

Méthode intelligente d'identification du potentiel de renouvellement urbain fondée sur la théorie du gène spatial : Shanghai

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Résumé : Dans la phase de planification par le stock, l'identification précise du potentiel de renouvellement devient centrale. L'étude utilise les toitures bâties de Shanghai, extrait des indicateurs morphologiques, identifie sept types de gènes spatiaux par modèle de mélanges gaussiens et prédit le potentiel par forêt aléatoire.

Mots-clés : gène spatial; renouvellement urbain; morphologie bâtie; modèle de mélanges gaussiens; forêt aléatoire; Shanghai

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1 Contexte de recherche

Le renouvellement urbain chinois passe de l'expansion à l'optimisation fine. La théorie du gène spatial permet de lire la morphologie bâtie comme expression mesurable de trajectoires historiques et sociales.

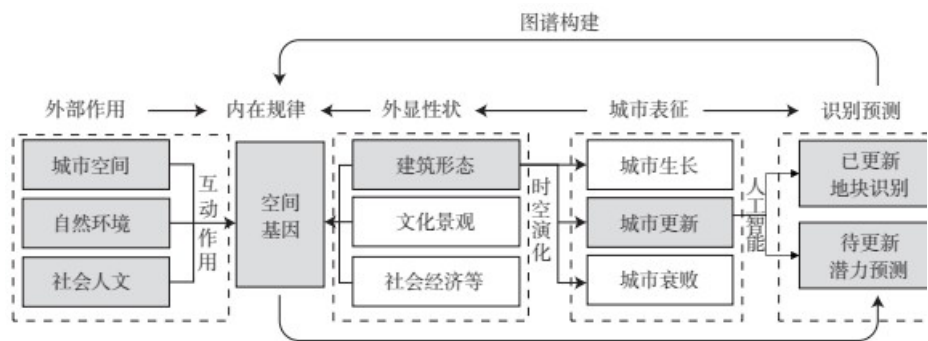


Fig. 1 Research framework

2 Revue des recherches

Les travaux sur la morphologie urbaine décomposent parcelles, rues et bâtiments, mais restent souvent statiques. L'étude introduit des données multiannuelles et un apprentissage automatique pour saisir l'évolution.

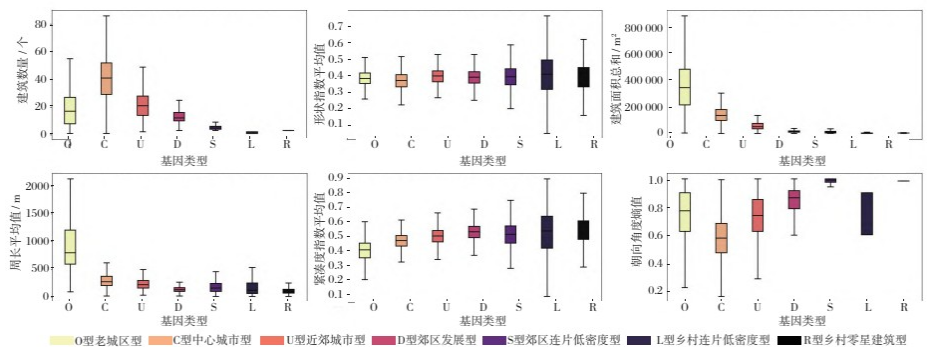


Fig. 2 Morphological characteristics of seven spatial-gene types in Shanghai, 2016

3 Morphologie bâtie de Shanghai

L'analyse couvre Shanghai avec des données de toitures 2016-2021 et six indicateurs : surface bâtie, périmètre moyen, entropie d'orientation, indice de forme, compacité et nombre de bâtiments.

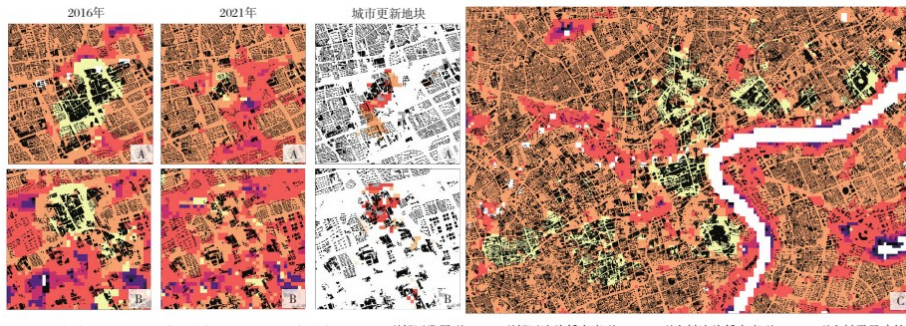


Fig. 3 Identified urban-renewal areas in Shanghai, 2016-2021

4 Identification des gènes spatiaux

Le modèle de mélanges gaussiens distingue sept types, de l'ancien urbain au rural dispersé. Les parcelles passant du type ancien au type central sont considérées comme renouvelées.

参数名称	设定值	取值范围
N_estimators	300	[100, 500]
Max_depth	None	[None, 20]
Max_features	'sqrt'	['sqrt', 'log2']
Min_samples_split	2	[2, 10]
Min_samples_leaf	1	[1, 5]

Tableau 1 Random forest parameters

5 Prédiction du potentiel

Le modèle de forêt aléatoire atteint une bonne précision. Les facteurs clés sont la surface bâtie, la distance aux centres de district, le périmètre, l'âge de construction, la centralité et le prix du logement.



图4 特征重要性分布（左）和SHAP蜂巢图（右）

Fig. 4 Feature importance and SHAP beeswarm plot

6 Conclusions

Le potentiel élevé se concentre entre anneaux et dans plusieurs centres anciens. La méthode fournit un outil pour une gouvernance mégapolitaine plus précise et dynamique.



Fig. 5 Predicted renewal potential in representative districts

Tab.2 List of high-potential areas for urban renewal

区域	更新高潜力地区
浦东新区	三林镇、北蔡镇、祝桥镇
长宁区	虹桥街道、程家桥街道、华阳路街道、江苏路街道
黄浦区	小东门街道、老西门街道、南京东路街道、瑞金二路街道
普陀区	真如镇街道、桃浦镇、长风新村街道、长寿路街道
静安区	天目西路街道、大宁路街道、共和新路街道、彭浦新村街道、静安寺街道、南京西路街道
虹口区	嘉兴路街道、广中路街道
杨浦区	江浦路街道、四平路街道、五角场街道
徐汇区	田林街道、漕河泾街道、龙华街道、徐家汇街道、天平路街道、湖南路街道
闵行区	华漕镇、七宝镇、马桥镇、梅陇镇、吴泾镇、莘庄镇、浦江镇
宝山区	大场镇、杨行镇、顾村镇、高境镇
松江区	中山街道、永丰街道、泗泾镇、新桥镇、车墩镇、九亭镇、洞泾镇
青浦区	香花桥街道、夏阳街道、华新镇、赵巷镇、徐泾镇
奉贤区	南桥镇
嘉定区	新成路街道、江桥镇、安亭镇、马陆镇
金山区	朱泾镇、金山卫镇
崇明区	城桥镇

Tableau 2 List of high-potential urban-renewal areas

Références

- [1] Zhu Yuxi, Zhu Le, Yang Jianqiang. Multiple deprivation indices in identifying British urban-renewal areas [J]. Urban Planning International, 2025, 40(1): 97-106.
- [2] Desjardins X. Greater Paris and its lessons for metropolitan strategic planning [J]. Town Planning Review, 2018, 89(1): 1-22.
- [3] Ahlfeldt G M, Maennig W, Richter F J. Zoning in reunified Berlin [M] // One Hundred Years of Zoning. Springer, 2017.
- [4] Mao Yu. Innovation in urban health assessment for renewal planning [J]. Planners, 2022, 38(2): 114-120.
- [5] Duan Jin, Shao Runqing, Lan Wenlong, et al. Spatial genes [J]. City Planning Review, 2019, 43(2): 14-21.
- [6] Shan R, Zhang S, Li K. Changing traditional urban fabric in Shanghai old town [C]. IPHS Proceedings, 2022, 19(1): 273-284.
- [7] Li Xu, Li Ping, Luo Dan, et al. Evolution and prospects of urban morphological-gene research [J]. Urban Development Studies, 2019, 26(10): 67-75.
- [8] Delmelle E C. Mapping the DNA of urban neighborhoods [J]. Annals of the American Association of Geographers, 2016, 106(1): 36-56.
- [9] Wilson A. Urban and regional dynamics: hierarchies, DNA, and genetic planning [J]. Environment and Planning B, 2010, 37(5): 823-837.
- [10] Salvati L, Ferrara A, Chelli F. Long-term growth and metropolitan spatial structures [J]. Geografisk Tidsskrift, 2018, 118(1): 56-71.
- [11] Fleischmann M, Feliciotti A, Romice O, et al. Numerical taxonomy of urban form [J]. Environment and Planning B, 2021, 49: 1283-1299.
- [12] Fleischmann M, Romice O, Porta S. Measuring urban form comprehensively [J]. Environment and Planning B, 2020, 48: 2133-2150.
- [13] Cheng Haomiao, Wang Bowei. Morphological assessment of urban sprawl in Shanghai's Xinjiangwan area [J]. Housing Science, 2017, 37(3): 46-52.
- [14] Hu Xuefeng, Yan Yan, Zhu Xiaohui, et al. Quantitative identification of spatial genes in characteristic towns and villages [J]. Urban Planning Forum, 2022(S2): 221-228.

- [15] Zhang Zhonghua, Wang Xuesong. Spatial-gene identification in Qingmuchuan traditional village [J]. Journal of Northwest University, 2025, 55(2): 420-437.
- [16] Ma Li, Yang Tao. Gene mapping of ethnic architecture in the Three Parallel Rivers region [J]. Chinese & Overseas Architecture, 2025(6): 1-11.
- [17] Xu Yunfei, Li Yu, Liu Suyi. Extracting and quantifying spatial genes in traditional small towns [J]. Urban Development Studies, 2023, 30(3): 73-80.
- [18] Gao He, Wang Cong. Spatial evolution of Daqing's historic urban area based on spatial-gene theory [J]. Architecture & Culture, 2025(3): 175-177.
- [19] Wang Shusheng. Genes of Chinese urban mountain-water landscapes and modern inheritance [J]. Urban Development Studies, 2016, 23(12): 1-4.
- [20] Zhang Tingwei. Theoretical origins and paradigm shifts in urban renewal [J]. Urban Planning Forum, 2020(1): 9-16.
- [21] Wu Nan, Zhang Xianfeng, Yu Shiwei. Superimposed scenes in historic-district renewal [J]. Interior Design + Construction, 2025(1): 118-119.
- [22] Jin Yanli, Li Tian, Guo Peng, et al. Historic-district renewal strategies under spatial-gene theory [J]. Sichuan Architecture, 2024, 44(S1): 123-125.
- [23] Gao Haifeng, Chen Haochi, Lin Changyuan, et al. Landscape spatial genes and renewal design in Lingnan water towns [J]. China Rural Water and Hydropower, 2025(7): 12-17.
- [24] Wang Fangliang, Zhang Qi. Renewal of an old-city transport-hub district from an area-coordination perspective [J]. Urbanism and Architecture, 2024, 21(15): 109-113.
- [25] Moudon A V. Urban morphology as an emerging interdisciplinary field [J]. Urban Morphology, 1997, 1(1): 3-10.
- [26] Conzen M R G. Alnwick, Northumberland: a study in town-plan analysis [J]. Transactions and Papers, 1960(27): iii-122.
- [27] Zhou Tao, Li Jing. Evolution of planar form in Chinese urban blocks [J]. Human Geography, 2014, 29(5): 56-62.
- [28] Yang Yongchun, Zhang Lixi, Li Zhiyong, et al. Building-oriented urban-renewal research in Lanzhou [J]. Scientia Geographica Sinica, 2009, 29(1): 36-41.
- [29] Wang Lin. Urban-renewal typology and strategy in Shanghai [J]. Shanghai Urban Planning Review, 2023(4): 8-14.
- [30] Steiniger S, Lange T, Burghardt D, et al. Classification of urban building structures [J]. Transactions in GIS, 2008, 12(1): 31-59.
- [31] Dibble J, Prelorendjos A, Romice O, et al. Morphometric foundations of urban-form evolution [J]. Environment and Planning B, 2017, 46(4): 707-730.
- [32] Jiang Ying, Li Yige, Duan Jin. A pathway for identifying and extracting spatial genes [J]. Urban Planning Forum, 2025(1): 18-24.
- [33] Duan Jin, Jiang Ying, Li Yige, et al. Meaning and mechanisms of spatial genes [J]. City Planning Review, 2022, 46(3): 7-14.
- [34] Huang Yilun. Planning strategies for old-area renewal in megacities: Shanghai [J]. Shanghai Urban Planning Review, 2023(6): 61-68.
- [35] Liu Z, Tang H, Feng L, et al. CBRA: multi-annual high-resolution building rooftop data in China [R/OL]. Zenodo, 2023.
- [36] Jochem W C, Tatem A J. Mapping multi-scale settlement patterns with the R package foot [J]. PLOS ONE, 2021, 16(2): e0247535.
- [37] Hsieh C M, Huang H C. Identifying potential wind corridors for urban cooling [J]. Computers, Environment and Urban Systems, 2016, 57: 130-143.
- [38] Polsby D D, Popper R D. Compactness as a procedural safeguard [J]. Yale Law & Policy Review, 1991, 9: 301.
- [39] Dempster A P, Laird N M, Rubin D B. Maximum likelihood from incomplete data via the EM algorithm [J]. JRSS B, 1977, 39(1): 1-22.
- [40] McLachlan G J, Lee S X, Rathnayake S I. Finite mixture models [J]. Annual Review of Statistics and Its Application, 2019, 6: 355-378.
- [41] Wang Jingli, Liu Yilun, Ma Haoxiang, et al. Urban-renewal potential in Shenzhen using open big data [J]. Areal Research and Development, 2019, 38(3): 72-77.
- [42] Wu Wenheng, Shi Haijin, Yang Bihong, et al. Renewal-potential analysis for urban enterprise-community land [J]. Acta Geographica Sinica, 2021, 76(10): 2391-2406.
- [43] Liu Chao, Chen Shuxi, Huang Zhiyi, et al. Urban-renewal potential assessment using multisource data [J]. World Architecture, 2023(7): 18-19.
- [44] Wang Haiyun, Wang Hongmei, Zheng Minhui, et al. Planning-based potential analysis for three-old renewal [J]. Modern Urban Research, 2015(3): 78-85.
- [45] Xu Xuelin, Ma Yi, Zhu Zhengwei, et al. Renewal-potential assessment of Xiamen coastal space [J]. Planners, 2022, 38(2): 121-126.
- [46] Liu Zhuyang, Dong Jian, Chen Chen. Identifying urban-renewal potential areas using open data [J]. Journal of Urban Studies, 2024(5): 89-95.
- [47] Long Yuntao, Gu Jie. Urban-village renewal based on potential and building-quality assessment [J]. Journal of Urban Studies, 2022, 43(2): 59-64.
- [48] Bo Mingyang, Dai Daixin, Liao Wandi. Coastal-city resilience under compound rain-heat risk [J/OL]. Landscape Architecture, 2025: 1-25.
- [49] Zhou Zhihua. Machine Learning [M]. Beijing: Tsinghua University Press, 2016.

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